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ABSTRACT

Since the major activity of the school is the development of students into productive adults, decisions in school management should enhance the processes that facilitate development of the child. Rational decisionmaking in school management necessitates coordination between school boards and school administrators. Boards of education must determine their systems' goals and available resources. Administrators then must assess the achievement of students in relation to these goals and recommend alternative strategies for needs not being met. In such a model of decisionmaking, feedback is crucial to the rationality of the decisions. To accrue appropriate feedback, school managers should determine gains made by students under their jurisdictions. This measurement of gain can be made only by ascertaining the differences in achievement at two time periods, rather than by comparing achievement results with some national standard. Collection and analysis of a variety of information allows administrators to proliferate subgroups and to determine the educational shortcomings of each subgroup. (Research for the study was funded under an ESEA Title III grant.) (RA)

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DECISION MAKING IN THE PUBLIC SCHOOLS

By

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As Consultant To

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to Prepare Educational Planners for California

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FOREWORD

The heart of the school executive's function is decision making. Many treatises written on the subject have advocated a variety of approaches toward simplifying the decision-making process. It remains as the core element in school management and administration.

This training manual is a brilliant attempt to apply some of the principles of quality control to the areas of decision making in the public schools. It identifies some productive avenues toward a realization of automatic decision making in many of the areas heretofore capturing the attention of top-level management.

The dimension of practicality with the use of actual data is provided herein through the use of pupil records and achievement test scores. Most of these data were drawn from the experience of the New York State Education Department. They have been summarized through Mr. Armstrong's long experience with schools and school board operations.

This provocative booklet can provide some valuable insights for school executives as they face this perennial problem of decision making--a process that lies at the heart of successful school management.

--Jefferson N. Eastmond
Assistant Project Director
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I. THE CHALLENGE OF THE DECISION-MAKING PROCESS

Management is an endless series of decisions. Each action of a manager is a choice between alternatives, a decision. Management starts with a goal or value to be achieved. The chief executive of a nation has very broad goals of providing a good life for the citizens of his country or of leading them to world dominance in accordance with his value system. At successively lower levels the management works with lesser goals which fit into the overall national or cultural goals. Thus, the road builder's decisions revolve around how to build roads efficiently. The educator's decisions revolve around the ways of helping children develop into the kind of adults the society needs or wants.

Ancient Methods of Decision Making. The primitive leaders made their decisions by snap judgments, magic and experience. Some snap decisions reflected the whim of the moment. These did not contribute to achievement of ultimate goals. Other snap decisions may have been aimed at ultimate goals, but such decisions are treacherous and man has learned that he cannot afford the consequences of such actions. The highest level of decision making for long periods of time was embedded in magic. The leader consulted a priest, a witch doctor, an astrologer, etc. Even in Roman times, high officials would have a priest (Augurs) consult the entrails of a sacrifice or the flight of birds, and others would consult oracles. The most common method of decision making goes back to early davs and is reflected by the spontaneous use of the cumulative experience of living. This is the consultation of the wise men of the tribe which was almost universal in primitive people. As culture advanced, men learned to organize

their experience in better and better systems and to arrive at decisions that more certainly moved toward the desired goals.

In modern decision making, the manager is trying to anchor every decision in organized knowledge. For this purpose the manager is required to have, or must be supplied with, an extensive knowledge of the decision-making area. He reads books and makes notes on his reading in the area of his decision making. He consults experts when he feels his personal knowledge is inadequate. He employs subordinates to supplement his knowledge. Even when all of these things are done the manager may still find himself forced to make decisions that involve areas of uncertainty.

Recent Advances in Decision Making. The Twentieth Century has seen the blossoming of many formal aids to decision making. One of the most recent has been game theory.[1] This entails the setting up of a model or game concerning the point at issue, the careful exploration of every possible alternative and the estimating of the probabilities of the alternatives. This reduces decision making to a systematic probability estimation of perceived decision consequences. It is a methodological adjunct to decision making, but its limitation is that in most practical situations it is very difficult to estimate the full range of probabilities accurately.

Another closely related system of decision making is "operations research." In this system the problem facing the manager is described in detail and with great precision. A task force of experts drawn from selected disciplines then study the problem and apply their collective multi-disci-

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[1]As an illustration, see Clark C. Abt, Games and Simulation in Education, a paper presented to the School Scheduling Symposium, Stanford University, July, 1967.

plinary knowledge, available through individual task force members, in an effort to resolve the problem. It is a method of trying to bring all scientific information and techniques to bear on the specific problem. The most serious limitations of this method are the shortage of persons suitable to be task force members and the expense of the operation. It cannot be used cost-effectively for routine decision making, but it has proven especially valuable in decision making that involves the resolution of complex problems.

An older system of arriving at decisions, particularly broad policy decisions, is the survey. In this, experts study and prepare systematic reports in all phases of the problem. For instance, when the New York State Regents wanted to establish new policies for education in New York State, they secured funds for the Regents Inquiry which surveyed all phases of education in the State. The survey method of arriving at decisions is very useful for certain major problems, but it is expensive and slow. A survey is likely to take months or years. Moreover, when the survey is completed it does not directly yield the answer. The answer has to be derived by the responsible person through an analysis of the information and an evaluation of the value system supporting the decision-making area. A carefully structured survey assures that the person responsible for making the decision will be provided sufficient information for decision making.

An outgrowth of the survey method, which was in reality a sort of blunderbuss approach to securing all available information, is the modern management planning technique where the essential steps required for a decision are spelled out and information requirements are specified. Decisions still must be made by top management, but they are facilitated by a

systematic appraisal of decision-making requirements.

All of the above methods of decision making are helpful and have made major contributions to the art of management. However, these methods are primarily useful for important decisions that are made only on occasion. Attention must also be given to the needs and problems involved in routine decision making.

Routine Decision Making. Many decisions are subordinate to other decisions. These subordinate decisions flow logically from a combination of ascertainable information and prior major decisions. If one could pre-establish relevant information and major decisions, a late generation computer could facilitate the making of subordinate decisions. Actually, in many operational situations a computer is unavailable, but in general, if the decision could be made by a computer, it can be made by an individual if he is properly instructed.

In the yesteryear, the housewife managed and controlled the temperature of the house. Periodically she added fuel and shook out the ashes. When the house was cold, she opened the drafts. When it was warm, she closed them. All day long she was busy making decisions and controlling the temperature.

The job of temperature control was one of the first jobs that embryonic automation took over. First came a sensing device. A thermometer was installed which the housewife could use to determine relative cold or warmth. It took the guesswork out of part of her job. Then, the thermostat was developed to control the air temperature in the house. Instead of assisting her in temperature decisions, it automatically controlled the temperature in any range she decided upon. The contol device was programmed for action

based upon her temperature range selection decision. Eventually the stoker took over the job of adding fuel and removing ashes. Thus, the housewife was free of almost all control duties except for the initial decision requirement relative to selecting a desired temperature range. Occasionally, she might decide on a different temperature and reset the thermostat. All subordinate decisions were automated.

Automatic Feedback. The ideal of management control is to secure automatic feedback and direction from the results of performance to support decision-making requirements. Automation is being increasingly used in more and more areas of decision making. The automatic pilot of an airplane has raised automatic control facilitation in decision making to a high level. The automatic power plant or oil refinery is perhaps a better illustration. It is too much to hope that all routine decision making can be transferred to automatic control devices, but the demands of routine decision making can be reduced in many situations.

Accounting has contributed greatly to the simplification of decision making, since it is a feedback system somewhat parallel to the feedback of temperature from the room to the furnace. The accounting record categorizes information relative to revenues and expenditures, organizes this information in a defined fashion, and reveals it to the decision maker. In many cases the decisions are almost automatic. For example, if the accounting record shows that the margin of revenues over expenditures is reasonable, then one obvious decision in private enterprise would be to continue in business. In public accounting, if the accounting record shows progress in accord with the budget, a similar automatic decision to carry on is logical. When less satisfactory reports come in, the decision maker

must go out and find the reason for the unsatisfactory result. As process records become more complete, less inquiry effort is required in problem solving by the decision maker. If feedback is fully adequate, the decision can become automatic. If feedback is almost automatic, the decision can be semi-automatic.

An advancement in simple money accounting records is gained when a record is kept of units of work done and this record is then compared to the expenditures reported in unit accounts. This is known as performance budgeting, and one of the most important gains is the increase of feedback information. The manager is provided additional information on work volume by units of performance which will enable him to make more semi-automatic decisions. In the event that expenditures grow too high, he can immediately see whether it is due to work load or inefficiency. Thus more feedback information is made available to the manager, the more precisely he will know what is happening in the organization and the more nearly automatic decision making will become.

Feedback and Classification. Where decision making becomes automatic or nearly automatic, the manager has:

1. Obtained feedback on all critical forces involved in performance and decision making.
2. Classified the types of decision making and problems that occur.
3. Reached generalized decisions on what to do for each type of routine problem.
4. Provided routine problem solutions to a memory bank which can be drawn upon as needed.

Thus, numerous decisions, which would have been decided in a hurry and with inadequate information, become a few major decisions that can be processed

with careful consideration of all important factors. When management makes a complex decision that affects many automatic or semi-automatic decisions, it has raised decision-making activities to an important level of responsibility.

Perhaps the preceding discussion and illustration is adequate to warrant a generalization in regard to routine decision making. A routine decision, standing alone, is relatively unimportant and must usually be made intuitively. As a consequence it may be made unwisely. If many routine decisions can be grouped into a class of decisions, the time required to study each class of decisions can be increased. The technique of establishing decision classes requires the accumulation of records in a systematic way, so that comparisons of routine situations can be analyzed, and decision classifications established. The systemization of record keeping and reporting to higher authority furnishes feedback, and feedback is at the heart of sound, routine decision making.

There is no reason for restricting application of the feedback principle to the accounting area. It can also be used in every other area of management and organizational performance. The problem is to describe and record events and activities in a definable, and measurable, systematic way. Preferably, this is done quantitatively in a manner that lends itself to statistical manipulation.

In industry, one of the most important areas for automatic decision making is factory statistical quality control. Here the activities and events being recorded are in relation to the quality of the product. In some cases every piece manufactured is measured. In others, a sample is taken at defined intervals. The essence of the procedure is that quality

be measured regularly in a precise and systematic way. If operations are continuing in accordance with the plans and instructions, the quality measurements should remain constant so that all variation can be accounted for by chance. If the quality measurements are in the defined limits, the automatic decision is to carry on. If they fall outside chance limits, the administrator must give the problem more specific attention.

When statistical quality control was first introduced, the tendency was to test the quality of the finished article. As experience was gained more and more attention was given to measuring the quality of every part as it was produced and all raw materials being utilized. As more and more components were measured the area of automatic decision making increased. When attention was focused on the finished product only, and a deviation was found, the foreman or plant superintendent had to search the production line until the probable cause of the problem could be identified and corrective decision-making action could be taken. As more and more components were subjected to feedback, more and more situations could be classified into automatic decisions. Today, in the well-managed industry, a very large portion of the administrative decisions required for maintenance of operations are automatic. Critical decision-making activities are moved forward to planning and designing quality control improvements for all routine procedures rather than maintaining the status quo.

Application of Feedback to Public Administration. The application of feedback principles to public administration is not easy. A public operation is oftentimes more complicated than a factory operation. It generally has a more complicated value system or systems involved and, therefore, its purposes are not usually as simple as the "profit motive". While this has

slowed down the application of the feedback principle, it is not a barrier to its application.

One of the genuine barriers is that much of public administration, whether it be the operation of prisons, schools or military services, involves human beings and humans are not easily classified into units of performance. This, too, should be a surmountable barrier even if it is a very real one. These two barriers, complicated value systems and complex human beings, have made it extremely difficult to classify the feedback to produce automatic decisions in public administration. These barriers interact to produce situations that call for new research into value systems and human beings.

The principal focus of this paper is on some new research in variation among human beings and a demonstration of how this can improve feedback and management in the public schools.

As already noted, in industrial quality control it is necessary to regulate the performance of all operations at specified proficiency levels. In a public institution dealing with human beings it would be necessary to detail performance specifications and specify required levels of proficiency for each person. In the public schools, for instance, it has often been assumed that chance would make successive grade groups alike in a school. Actually, this does not work out in practice and efforts to apply feedback methods in decision making have not worked out because of the variability of information being reported to management relative to student and teacher performance.

The Possibility of Achieving Automatic Decision Making. The reduction of public administration problems to specified types so that decision-

making activities can be facilitated will, require a great deal of detail effort. Many persons, even well-informed persons, will consider the work prohibitive. A later section of this booklet deals with the application of these ideas to the school situation. It outlines the difficulties which educational management will experience before useable results will be obtained.

There are two benefits to be gained. First, if a theoretically sound system can be devised, then improved management practice will result. With improvements, more complex theoretical systems can be reduced to practical systems. Second, late generation computers are so fast that many complex operations that would have been considered impractical a few years ago can now be made routine practices. Moreover, as can be seen in a later section of this report, the processes involved--classification and computation within classes--lend themselves to computer analysis and control.

II. THE SCHOOL BOARD'S DECISION-MAKING REQUIREMENTS

The school board is the connecting link between the public and the professional school staff. Ultimate power, in our system of government, rests with the people. They decide on the type of education wanted, as well as all the other myriad decisions of government.

Actually, the public cannot be expected to pay detailed attention to any particular phase of government. Ultimate power rests with the public, but the public exerts its power through its elected officials. In general, the public expects elected and/or appointed officials to act and reason in accordance with certain broadly accepted general assumptions. These broad general assumptions reflect the expectations and desires of the public. Public officials are expected to perform their functions in harmony with these assumptions.

As long as officials can do this, our system works smoothly; but when performance deviations occur, for any reason, there may ultimately come a time of public dissention and confusion with subsequent reduction of operational efficiency in our institutions. The schools are subject to many forces and there are signs of public dissent and cumultive friction developing. To minimize the effect of these frictions is an important responsibility of the school management.

School board members are either elected by popular vote or are appointed by elected officials. A school board is assumed to feel as the public does concerning basic values and competitive pressures for public funds. It generally has authority to select the chief school officer and to make broad policy decisions which govern his actions.

The chief school officer must integrate the broad policy decisions of the school board with professional know-how in order to solve the persistent and evolving problems of school operation. He gathers and analyzes information, formulates alternative problem solutions and makes recommendations to the school board. The information he provides to the board constitutes the factual basis for decisions. The theory of information handling is that, if information is adequate, the arguments and differences of opinion will be reduced to a minimum and end product decisions will be supported.

The Goal Should Be Unanimous Decisions. If members of the school board have common assumtions and possess relevant information, they will tend to come to fairly unanimous decisions. This results in a smoothly functioning school board and permits the superintendent to plan with confidence. Sometimes there are fundamental differences in the value systems of different school board members and, in many cases, basic splits in the value systems of the public itself. These differences should be made explicit in order that everyone recognizes the source of such differences. This will reduce the time that may be wasted arguing about details generated by widely different basic assumptions. For example, one person may believe that education is the major difference between a successful person and an unsuccessful person. Another may believe that there are inherent variations in individuals which education cannot overcome. It is possible that these two persons are likely to have very divergent views on what proportion of public funds should be spent on education.

The Information Needs of School Boards. School boards need to have information relative to the following four major areas of decision-making concern: (1) the availability of resources, (2) the needs of people (society),

(3) the achievement of pupils, and (4) alternative methods and strategies for meeting needs. Each of these will now be discussed.

1. The Availability Of Resources

The first information requirement of a school board centers on the general economic status of the supporting community. Many relevant questions must be answered; included among these are the following: what is the average income per family, the income per child and number of wage earners per family? Does the school district have sufficient resources, energy and information available to get the job done? If not, then what types of additional resources (human, physical, financial, and time) are needed and how can they best be acquired and allocated? What can be done to improve the efficiency and effectiveness of our current operation to reduce our expenditures of effort (costs) and establish a more cost-effective mode of performance? Where does the income originate? Is a large part of it rent, dividends and interest, or is it largely wages? Are incomes regular or subject to frequent variations? Is there a legal method by which the school can take a logical share of this income or are other methods of taxation imposed? For instance, if most citizens rent their homes, but school income originates from a real estate tax, then certain difficulties are experienced in securing proper support for the schools. If school income comes from a general sales tax, voted by the people, the availability of funds may be a function of economic activity.

Where there are large taxable resources, as in industrial areas, the people may vote liberal school support because the voters and payers may represent different groups. A common difficulty is experienced by school

districts in residential areas supported by a real estate tax base which must be levied against homes. Each home unit can only pay a limited sum without serious effort. This produces a large adverse vote on school budgets because the average voter is under heavy personal financial pressure. The school board needs to be well informed on all these matters so that it can adjust to the realities of its support group.

There is always ultimate danger to a society where minorities are ruthlessly used, and wealthy minorities are no exception to this general rule. Hence, school boards should move cautiously in using their power to tax when such action will affect a particular group that is politically weak. The danger is that the minority may ultimately devise a political lever in opposition and ruthlessness begets ruthlessness. Therefore, information and logic which convinces, rather than the power to coerce, minorities should be sought in school board operation.

2. The Needs Of The People (Society)

A critical factor in all school planning is the determination and justification of need. This is not a simple operation because it is an area of public debate in which people argue extensively, usually lack understanding and may even disagree on the underlying assumptions without realizing it.

The first step in establishing the needs of the people is to define the purposes of society and to clearly establish how education facilitates those purposes. In other words, a school board needs to establish a philosophy of education on which it can agree and utilize that philosophy in governing its actions. Most philosophies of education found in the literature are not satisfactory operational tools because they do not lend themselves to

decision making. A philosophy for decision making must be precise, rather than broad and ambiguous. Many fundamental differences of opinion can be concealed in most philosophical statements of purpose. An educational philosophy should be checked to see if its assumptions provide foundations for required decision-making activities. If it does not, then it is not an operational philosophy and should be strengthened. An educational philosophy for decision making should provide a limited number of assumptions from which all necessary decisions can be logically deduced, subject to assessment of available information.

Once the philosophy is established, the informational requirements of a school board will increase. New questions will be asked. Such questions may include: are children in our schools capable of becoming the kind of people society needs? If some of the pupils are not capable of becoming the kind of people society needs, what can these pupils become? Will they be a serious problem to society? If these pupils can be modified by schooling, what are the comparative costs of different modifications and how valuable would these modifications be to society?

What kinds of manpower and responsible adults are needed by society? Is the educational system producing enough professional workers? Is it producing an excessive number of unemployables? Do the adult citizens of the community have a proper sense of responsibility? What new types of specially trained adults will society need to keep pace with technological advancement? Are social attitudes changing so that education is an important prestige item? Are the religious and cultural institutions of the community strong?

Additional questions will be asked regarding gifted children, and

other groups. Typical of such questions are the following: are the more able children in this district securing a reasonable chance to fulfill the best opportunities available in society? What improvements in opportunity for such groups are possible with an increased per pupil expenditure of $100 a year? What specific losses would be experienced if there were a reduction of $100 a year expenditure per pupil? (The existing school data suggests that a change of $100 per pupil per year in a district where per pupil expenditure exceeds $600, would not be great for most kinds of children.)

Information of this kind would give the school board real building blocks which they could use in selecting a school program that would meet the will of the community. The present policy of assuming that extra expenditure will bring equivalent benefits, and that society needs these benefits, is so broadly accepted that it results in an almost complete loss of public control, and may well result in loss of public confidence.

3. The Achievement of Pupils

This is an area of vital concern to the school board and an area of considerable confusion in recent years. Are the pupils developing as expected into the kind of adults society needs? Are the pupils in one school doing as well as those in other similar schools? Are all types of pupils developing in accordance with acceptable models of expectations? Will all types of pupils be ready to make suitable contributions to society?

In the era of the one-room school, educators and laymen possessed a common understanding of what the curriculum should produce. If a child passed the second grade it meant that he had mastered certain skills and possessed certain knowledges. Each grade had its hurdles and everyone knew the exact nature of these hurdles. When the school board reviewed

the list of promotions and retentions, it had a clear understanding of what was happening in the school.

When the schools recognized that psychological damage to a child could result from retention and the subsequent separation from his normal peer group, the emphasis on promotion, or retention, was dropped. In some school districts all students were automatically promoted and these school boards lost their main yardstick for forming judgments regarding the effectiveness of the educational process.

In the era of the one-room school, emphasis for education was placed on its value in creating opportunity. The purpose of the school was to provide an opportunity to those who wanted it and who were capable of using it. If a person found the work unpleasant or too hard, he dropped out. Hence, most of those remaining in school exhibited progress and were learning. When the experience of society showed that those who stayed in school were more satisfactory citizens and workers than those who dropped out, school boards and legislatures swung over to the view that everyone should benefit from education, and education became compulsory.

Thus, during the period of time in which promotion was becoming more automatic, a great mass of students were, in a sense, becoming prisoners in the school. Schools no longer possessed adequate systems of measurement to tell the school board what was happening. An information vacuum resulted which ultimately led to the development of an extensive educational measurement movement. Unfortunately from the view point and needs of school boards, early measurement specialists focused their attention on measuring relative differences in pupils, rather than measuring the absolute educational growth of pupils. Even though some measurement special-

ists called attention to the need for absolute measurements, the prevalent need for relative measures was immediate and obvious. Thus, the main stream of the educational measurement movement became committed to relative measurement.

The result has been that schools know how each child is doing relative to the average child in a grade, but they do not know how each child is developing as an individual. In other words, there is reasonably adequate information on the relative efficiency of different schools, teachers, etc., but relatively little information on the actual performance capability of individual pupils at different stages in their development. Yet, the informational requirements of school boards in decision making usually centers upon the absolute performance of children.

School boards must make judgments regarding the adequacy of grade norms for decision making. No one seems to have this information. A recent study in New York State indicated that children reading at grade level in elementary school were not well equipped for high school work. The school boards need to have more information on such problems. They also need to know how many children, as they become adults, will be capable of various kinds of work. Translated to grade level, the school board needs to know what proportion of the children at completion of sixth grade can read, can do long division or handle complex fractions and decimals. Societal needs are not measured by what the average person does in the traditional, normal routine, but by the absolute requirements of the culture as it develops. Needs are absolute, not relative, and the school board must base its actions and think in terms of absolute measures of reality.

The almost exclusive use of results of relative scores of achievement in school reports has cast school boards and the public adrift, without a solid base from which to form judgments in the critical decision areas for which they are ultimately responsible.

There are some very simple devices available that would help school boards out of this dilemma. For instance, it would be helpful to have each teacher list who, in her estimation, possess serious reading deficiencies which make their successful employment as adults doubtful. Or, at an even simpler level, a listing of those students who are not expected to be able to read the ninth grade social studies textbook would provide a beginning basis for considering specific school problems.

Another area of information required for school board decision making centers upon what happens to children during the totality of their daily lives. How much time does a child have for school work? This requires information on the high priority activities of children in the community. In most instances, no one looks at the whole individual and it is therefore quite easy for various interests to demand too much time of the child. Thus, the demands of home, church, school and the child's need for recreation may exceed the time available to him. The school board has the responsibility for looking at the child's developmental problem from the community point of view.

4. Alternative Methods And Strategies

The school board, since it is responsible for broad policy decisions, must have information on what is possible and what is impossible. What alternative methods and means are available and which of these have been

found to be reliable in practice? Which alternative offers the greatest promise of meeting the needs? Which alternative strategy represents the most cost-effective approach to need satisfaction? What is the operational and management feasibility, as to practicality and acceptability, of each alternative method and strategy?

For instance, most school boards would like to adopt a policy of assuring quality and equality of educational opportunity, especially to the equivalency level of a satisfactory high school graduate. This is very different from the prevalent policy currently used which only encourages students to remain in school for twelve years. Obviously, there are techniques for making twelve years of formal education compulsory. But are there techniques for making everyone learn as much as society expects of a high school graduate?

School boards need to know if solution method alternatives and techniques are just theoretically available or practically available, in the sense of having been tried out and been found reliable in regular operations. Experimental evidence is not an adequate basis for school board policy decisions. Experimental evidence has to be verified through field tests before a school board should use it for policy formation.

Summary. The evidence points to serious decision-making problems which must be faced by the lay boards which govern the educational institutions. These boards generally lack the information required to clarify these problems. More attention must be given to providing the information base required for board decisions. It is hard enough for school boards to reach sound decisions even when provided the necessary information. But school staffs tend to expect firm and sound decisions even though they frequently fail to provide an adequate information base for decision making.

III. APPLICATIONS OF DECISION MAKING PRINCIPLES TO PUPIL ACHIEVEMENT PROBLEMS

The key activity of a school centers on the provision of an environment suitable for the development of pupils into productive adults. Decisions should always result in the enhancement of those processes which facilitate and guide the development of children.

If an educational manager is to make rational decisions, he must be able to measure educational outputs and relate decision making to changes in outputs. This is an easy operation to state, but a complicated one to implement. In order to measure outputs the manager must clearly define his goals and this constitutes a difficult task.

At first glance the manager might say that the district desires to teach all children certain arithmetic skills and that learning accomplishment can be measured by how well students do on standardized arithmetic tests. If a standardized arithmetic test was selected and administered annually, the manager could base his decisions on pupil progress in relation to established test norms.

This might not be sound, because the standardized achievement tests are at best, just a sampling of what a child needs to know and, once the test is selected, teachers and textbook writers can direct their efforts to teaching in terms of the test instead of teaching arithmetic fundamentals. There is no routine procedure for overcoming this difficulty and hence, all management decisions must be biased in terms of an intuitive judgment of the adequacy of the measure being used.

Even when an arithmetic test measures progress in learning arithmetic fundamentals properly, arithmetic constitutes only one element in an array of learning experiences required for the development of a child into a socially productive adult. The real test is

what the adult can do and a commonly held minimum requirement is that he be employable. Regardless of the levels of proficiency exhibited by a student while in school, his functional performance as a responsible adult in society constitutes the value base for determining the effectiveness of the school. The development of semi-automatic decision making requires a complete assessment of society's expectations with respect to adult performance and then defining educational requirements for the achievement of desired end products. In other words, the solution requires a philosophy of education framed in such a way that the immediate product can be evaluated and the details related to the ultimate product.

However, tests do have considerable validity and, with an understanding of these limitations, a model for decision making can be worked out that such a model will force steady improvement in school practices toward the perfection of segments of the school program. In a broad outline, the school executive must have a statistical routine that will automatically identify relapses in teaching methods or other school practices and exert pressure on all concerned to correct the difficulty.

At the same time, he must identify improved techniques and diffuse the improved techniques to all parts of the school system. When improved methods have been established or adopted, the process should insure that these improvements are maximized.

The Measurement Problem. The measurement problem that is of most interest to the school manager is the gain made by pupils in his institution. The accomplishment of the institution can be expressed in a simple gain formula wherein the skills and knowledges possessed by pupils at the end of the enrollment period minus what they exhibited at the start of the same period constitutes gain.

If there were an easy way of measuring the educational development of children when they enter school and what they have later on, there would be no need for the subsequent discussion. However, there are actually many fundamental and intervening problems to overcome. First, knowledge can only be measured by sampling and, while knowledge can be sampled, there is no way to measure that part of one's education that comprises learning to learn or acquiring an approach to learning. Hence, there is serious difficulty in estimating what the child brings to the school and what he takes away.

A test in and of itself has no useable absolute scale of values. One does not know the relative value of the various questions. Therefore, the usual method of scaling an achievement test is to give it to a broad group of representative children and scale it by the manner in which these representative children perform. This means that the school executive, under present practices, is generally satisfied if pupils under his responsibility are doing considerably better than the general average. No one knows, using this approach, what results could be attained by average children under optimum school conditions.

Perhaps even more serious, no one knows how these results could be expected to change when the test is administered to different types of children. When norms are established based upon performance by a total cross-section of all kinds of children, there is no satisfactory means of evaluating the differences in response by sub-groups among the children.

Social scientists have generally recognized that our modern American communities are highly stratified. The residents of some suburban towns are overwhelmingly professional, other suburban industrial towns are generally populated by skilled workers, the big city slums are largely populated by the unskilled. Social and pupil expectations in these different communities are

found to be very different and a composite national standard will not yield a reliable index of success or failure in widely divergent schools.[1] Thus, even though existing school measurement devices are not satisfactory for managerial control, the first steps must be taken using tools available. As the importance of additional measurement requirements are established, new measurement devices will be designed that meet management needs. The needed types of measures seem to be theoretically possible.

The Character of Statistical Reports. Schools cannot be run like experiments. All parents want their children to have the best educational treatment available. Parents do not want their children to be experimented with and, therefore, controlled investigations in which new methods are tested using control groups are often of little use to the practical schoolman. He must make progress by evolutionary steps.[2] He hypothesizes that improvement lies in a certain direction and takes very small steps in that direction. He follows his operating statistics and, if they are favorable as he takes those evolutionary steps, he moves progressively forward. If they are unfavorable, he retreats. This necessitates that his operating statistics must be reliable so that small differences are significant. It also requires that the variability which is unaccounted for must be minimized.

Pilot Analysis of Data. The first step in solving a problem of the type described in the foregoing paragraphs is to secure data on a large group of

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[1]Samuel M. Goodman, The Assessment of School Quality. The University of the State of New York, The State Education Department, Albany, 1959.

[2]G.E.P. Box, The Exploration and Exploitation of Response Surfaces. Technical Report No. 4., Philadelphia Ordinance District, Department of the Army with Institute of Statistics, North Carolina State College, Raleigh, 1954.

pupils. These data must be obtained for the critical measure of achievement and also for classificatory information on the individual pupils. The classificatory material is necessary to establish groups of pupils by all identifiable important differences. The data preferably should be placed on IBM cards or some other sorting system so that they can be grouped successively by first one classificatory item and then another. For instance, one logical classificatory item might be the socioeconomic status of the pupil. The cards would be sorted by socioeconomic status and the frequency distributions of the achievement test under consideration, say the arithmetic test, would be secured for each socioeceonomic group.

The average values of the arithmetic test for the various socioeconomic groups would be compared to see if there were significant differences. If there are significant differences it is evidence of a variation in children of different socioeconomic groups in their prior learning or readiness to learn. In any case, if one is to compare the success of a school from time to time or the success of one school with another, it is necessary to equate the children involved.

Socioeconomic status is one available way of equating children. This does not require matching of the children, but does require comparison of comparable groups. Thus, results for high socioeconomic status pupils in one school should be compared to high socioeconomic status children of the other school, etc. Student performance in one school may be better for one type of pupil and in another school student performance may be better for another type of pupil.

Comparisons must be made by type of pupil rather than by any average, because the average may not represent a real quality of the school. For instance, if a school does well with the high socioeconomic group and poorly with the low,

it may be about average for the total; but this is meaningless for management decision making. The school executive needs to know which performance areas are being well cared for and which performance areas are in need of attention.

The illustration just cited brings out one of the important characteristics of sound management statistics. The measurement must deal with a single force or at least a very limited number of forces. If more than one force is involved in a single measurement, there is always danger of having one force registering favorably and another force offsetting it by an unfavorable indication. The resultant average is quite meaningless, because it would indicate no need for attention, when actually there may be an urgent need for action to overcome some unfavorable condition.

Notice should also be taken at this point that the frequency distribution of scores for a grouping like socioeconomic status can be measured by percentage above or below some arbitrarily selected point, as well as by comparing averages. The average describes one characteristic of the frequency distribution; namely, the balance point between high and low observations. The percentage indicates how much of the distribution is at one end or the other. As will be shown later in this discussion, there are certain advantages in using the percentages because percentages are usually influenced by fewer forces than an average and, hence, may be better management measures. In the illustration above, an easy method of using percentages is to find the percentage of a group of pupils above grade level or the percentage below grade level. Significance of differences can be computed for the percentages as readily as for the average.

If one has a considerable number of cases, it is often profitable to make a frequency distribution of the groups and study the nature of the distributions. A bi-model distribution suggests that there are two sub-groups. A tri-model

distribution would suggest three sub-groups. A long, strung out distribution without important modes would suggest a search for correlations or other complicated relationships.

This process of analyzing by sub-groups should be repeated for each classificatory item available. Those showing no significant differences can be discarded. The rest must be used in designing a control system.

Designing the Control System. When all available classifications have been canvassed and the significant ones identified, the analyst can set up an overall classification system. This will result in sub-groupings in which every member of a sub-group shares the same significant class characteristics. Thus, in the case of data on the arithmetic achievement test in a current study, it was found that sex, socioeconomic status, intelligence, and achievement above grade versus achievement below grade were important forces in determining the quality of work done in a school. The control grid should, therefore, consist of the following class characteristics for a subject (such as arithmetic): a grade (such as 4), sex (such as male), intelligence and socioeconomic status. Such detailed classifications require large numbers in the original sample to give adequate size groups in each sub-class. Where the numbers are inadequate, the errors of multiple-force measures must be accepted. The ideal is to break the data down at least as far as indicated above. Socioeconomic status and intelligence are somewhat correlated and, hence, one or the other can be used without experiencing too serious of a loss although there are real gains if they can both be used.

Thus, for each grade and subject, if we use a three-way classification and socioeconomic status, there are 36 measurements or observations. For boys, the first classification is by intelligence (three-ways), the second by

socioeconomic status (three-ways), and each classification is observed for above and below grade. Thus, there are three times three times two observations or 18 observations for boys and 18 for girls or a total of 36. If one assumes five important subjects for each grade, the total measures for a grade would be 180 and for 12 grades this would total 2,160.

Since schools also share responsibilities for personality development and health, these areas could be analyzed and tested. The inclusion of these areas would add many more measures and in practice even more would be added as the subject tests might logically be broken into sub-tests such as arithmetic computation and arithmetic problem solving. The tremendous number of measures involved indicates the complexity of decision-making information available in a school system. Actually, in current practice a school executive does not think about each of these measures as requiring decisions. When he observes an unsatisfactory situation, he acts on it ignoring the many that have not attracted his attention. Thus, decision making, as it is generally exercised, is based more on intuition than on the logical analysis of available information.

Standards for the control system. An individual school can set up standards for itself by measuring where it is, based upon test results obtained during the year, and structuring this measurement information into a standard. In subsequent years, the school manager would consider as good those items that improved from the preceding year. Items would be considered as poor if they regressed. An individual school would make only slow progress working in this way. Performance would be limited due to inadequate variation required to set new goals as rapidly as may be desirable and in many cases chance variation would result in confusion.

Where a central agency collects data from a number of schools a more

satisfactory set of standards can be developed. The average of the upper quartile of a group of schools for each item can be used by all the schools as standards. A school can be reasonably satisfied if it does as well as the average, but if it wants a stimulating standard, it can use the upper quartile of the group.

As gains are made, new and higher norms are set and the laggard schools are put under the pressure of the increasing differential existing between their achievement and the average achievement of the group.

Interpreting The Control System. The school manager must set priorities, because he cannot do everything at once. There are a number of devices for doing this. A simple one is to make up a grid like that shown in Table 1. Then one can put a green x in each cell where the school is better than the State or group average. A red x can be placed in each cell (or "window") where it is less than the State or group average and an orange x where it is about the same as the State or group average.

Table 2 illustrates this same idea for boys, but omits the intelligence classification and depends on the socioeconomic classification to cover both areas. A school executive can observe areas of green, red and orange and see the general areas where his attention is required. If the elementary school shows red, but the high school is generally green, he can focus his attention on the elementary school.

Similarly, if a subordinate is responsible for the elementary school or a supervisor is responsible for a subject, each can observe when trouble is developing in his area and take corrective steps without waiting for action at higher levels. Each knows that he must maintain the standard set. This is automatic decision making from the point of view of the top management person.

TABLE 1

Arithmetic--Grade 4--Boys

Intelligence	Low						Medium						High					
Socioeconomic	White Collar		Skilled		Unskilled		White Collar		Skilled		Unskilled		White Collar		Skilled		Unskilled	
Grade Level	Above	Below	Above	Below	Above	Below	Above	Below	Above	Below	Above	Below	Above	Below	Above	Below	Above	Below

TABLE 2

Windows by Grades

Grade	Boys																								Total
	White Collar						Skilled						Unskilled												
	Above Grade			Below Grade			Above Grade			Below Grade			Above Grade			Below Grade								
	Ar	Rd	WS	Ar	Rd	WS	Ar	Rd	WS	Ar	Rd	WS	Ar	Rd	WS	Ar	Rd	WS							
1	#	+	0	+	+	#	0	#	+	+	0	#	#	#	0	#	0	0							
2	#	+	0	+	+	#	0	#	+	+	0	#	#	#	0	#	0	0							
3	#	+	0	+	+	#	0	#	+	+	0	#	#	#	0	#	0	0							
4	#	+	0	+	+	#	0	0	+	0	0	#	#	#	0	#	0	0							
5	#	+	0	+	+	#	0	0	+	0	0	#	#	#	0	#	0	0							
6	#	+	0	+	0	#	0	0	+	0	0	#	#	#	0	0	0	0							
7	0	+	+	+	0	#	0	0	+	0	+	#	#	#	0	0	0	0							
8	0	+	+	+	0	#	0	0	+	0	+	0	#	#	0	0	0	+							
9	0	+	+	+	0	#	0	0	+	0	+	0	#	#	0	0	0	+							
10	0	+	+	+	0	#	+	0	+	+	+	0	#	0	0	0	0	+							
11	0	+	+	+	0	#	+	0	+	+	+	0	#	0	0	0	0	+							
12	0	+	+	+	0	#	+	0	+	+	+	0	#	0	0	0	0	+							
#	6						12			3						6	7	12	9			5				60
Total +		12		6	12	5			3		12	6												5	61
0	6			6		7			9	9		6	6	5		3	12	7	12	7	95				
Grand Total	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	216				

+ Green: Above the average for the State

0 Orange: Average, about the same as the average for the State

Red: Poor, below the average for the State

Similarly, individual teachers can observe their successes and failures and act automatically in advance of supervisory directives. The measures reported in Table 2 are indicators of the effect of the school on the pupils. They do not in themselves give any indication of the school policies causing them. Their power comes from the homogeneity of the groups represented in each measure. The raw material the school received in the defined group will be substantially the same from year to year and from school to school. The school executive can then reasonably assume that noted variations from year to year or from school to school are a result of school policy and cannot be attributed to chance or unknown forces. Measures which fluctuate from many causes are the bane of good management. In such cases, the manager cannot identify whether the causes are something he can control or something beyond his control.

They do not identify the forces under control of the manager. He must still study the likely source of differences. For instance, suppose he observes that an entire elementary school is doing poorly. This would suggest that something common to the whole elementary school is at fault and he might logically study the elementary school principal, the general pay scale for elementary school teachers, the policy for providing supplies and teaching aids to the elementary school, etc. However, if most of the elementary school grades were good, but one grade was poor, then suspicion would fall on individual teachers. If arithmetic were poor, but other subjects good, the manager might well review the textbook, the arithmetic supervisor and the curriculum.

Even with the help of a measurement strategy, decisions would not be automatic, but would require further observation and judgment. The difference

is that the attention of the school executive is directed toward the areas of difficulty. He has a systematic pattern of reporting that suggests lines of reasoning, a la Sherlock Holmes, that carry him quite directly to the necessary decision. Further, the same measurements can stimulate subordinates to make sound decisions without referral to higher levels. This discussion should also note that certain measures might tend to favor one socioeconomic group or another, or might show that children doing above average work are doing relatively better than children doing below average work. The correction of these types of errors will probably be more difficult and more complicated.

A somewhat more complicated but useful device is to scale the measures so that scale values are comparable from one measure to another. When this is done, all the measures of a school can be put together in a frequency distribution. A closely grouped, single moded frequency distribution would indicate a school in which the manager is doing a consistent job. A multi-moded distribution would indicate relative failure in some area, such as above grade versus below grade or elementary school versus high school. In fact, part of the process of analysis would consist of making sub-distributions by all the available classifications. For instance, they could be grouped by sex, grade, intelligence, socioeconomic status, subject, above grade and below grade. If classification of data indicated that the school under examination was strikingly different from the group-average in some item, then there would be reason for careful study. Tables 3 and 4 show some actual distributions[3] developed in New York State.

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[3]William Firman, et al., "Procedures in School Quality Evaluation." A Second Report of the Quality Measurement Project. First Draft January, 1961. The University of the State of New York.

Note in Table 3 that School A is better on the elementary school measures than on the high school measures relative to the group average. The early elementary years are revealed to be about average. The later high school years are shown to be well below average. School B is quite regular. School C is almost the reverse of School A. The measures are poor for the elementary grades, but almost average for the high school. School D is particularly interesting. This is a fine suburban school with many able children. The measures for some items or "windows" are very good and for others just about average. Further analysis (see Table 4) shows that this school is doing much better with the percentage above grade than with the percentage below grade. In other words, the school is giving unusual attention and education to the bright children ready to respond to the school program, but is not doing anything unusual for children normally at the bottom of the class.

TABLE 3

Windows for Various Grades[1]
Grades 4-8: Iowa Tests of Basic Skills
Grades 10-12: Iowa Tests of Educational Development

Scale	School A Grade Level 4	5	7	8	10	11	Scale	School B Grade Level 4	5	7	8	10	11
+9							+9						
+8							+8						
+7							+7						
+6							+6				2		
+5							+5		1		3		
+4	1						+4	3	1	2	5	1	
+3	1		2				+3	5	8	8	5	4	2
+2	4	2	2				+2	8	7	5	5	2	5
+1	7	3	6		1		+1	6	7	5	3	5	5
Average[2]	10	6	6	3	5	3	Average[2]	2		4	1	2	4
-1	1	11	3	5	7	5	-1					1	
-2		2	4	3	2	3	-2					1	
-3				3		3	-3						
-4							-4						
-5				1		1	-5						
-6							-6						
-7							-7						
-8							-8						
-9							-9						

[1]These tables are built up from tables for each school similar to Table II.[a] To prepare the table for School A, all observations for the fourth grade were plotted by amount in the column headed "Grade 4." Those for the fifth grade in the column headed "Grade 5." Thus, in the column "Grade 4," there is one observation at the +4 level. This means that one window was at this level. The reader cannot tell in this table whether it was reading or arithmetic, boys or girls, below-grade or above-grade. He can observe, however, that most windows in the "Grade 4" column (10) were at State average, and that there was only one below average. Thus, there is a high concentration of all observations around State (QMP) average in School A. School D's fourth grade presents a different picture: there is one concentration (or mode) at +1 of 6 windows, and

[2]Average of all QMP schools testing at approximately the same time.

[a]Refers to pages in Procedures in School Quality Evaluation, by William D. Firman.

Table 3 (continued)

Windows for Various Grades[1]
Grades 4-8: Iowa Tests of Basic Skills
Grades 10-12: Iowa Tests of Educational Development

School C							School D						
Scale	Grade Level						Scale	Grade Level					
	4	5	7	8	10	11		4	5	7	8	10	11
+10							+10				1		
+ 9							+ 9				1		
+ 8							+ 8			1		1	
+ 7							+ 7	1		1		1	
+ 6							+ 6	4	2	1			
+ 5							+ 5	3	1	1	2		2
+ 4							+ 4	2	3	4	4	1	2
+ 3			1				+ 3	3	2	2		3	2
+ 2				1			+ 2	1	2	2	2	2	2
+ 1				2	1	2	+ 1	6	4	1	3	4	1
Average[2]		2	1	5	5	6	Average[2]	4	6	5	2	2	3
- 1	5	8	5	9	4	6	- 1		5		2	1	3
- 2	10	9	2	5	5	2	- 2			1	2	1	
- 3	5	3	1	2	1		- 3						
- 4	3	1	2	1			- 4				1		
- 5							- 5						
- 6	1	1					- 6						

[1] another at +6 of 4. Thus, School D has some windows at a much higher level than others--it is not doing an equivalent job in all subjects for all pupils. Table 4, rather than classifying by grade, classifies by other factors such as sex, below-grade and above-grade. This indicates that bi-modality in School D is largely accounted for by the below-grade and above-grade split. The mode for below-grade is at 0 - +1 scale score level; and for above-grade, at the +4 - +5 - +6 scale score level, although some above-grade items are at the 0 - +1 mode.

[2] Average of all QMP schools testing at approximately the same time of year.

TABLE 4

Analysis of Windows With Respect to State Averages: Achievement Classified by Sex, In-grade Position, Subject Area and Socioeconomic Level*--Iowa Tests of Basic Skills

School A

Scale Score	Boys		Girls		Below Grade	Above Grade	Arith-metic	Read-ing	Work Skills	White Collar	Skilled
	Gr. 4	Gr. 5	Gr. 4	Gr. 5							
+5											
+4	1**					1	1			1	
+3			1			1	1				1
+2	2	1	2	1		6	3		3	2	4
+1	5		2	3	5	5	3	5	2	4	6
State Average	4	4	6	2	11	5	6	7	3	9	7
-1		5	1	6	8	4	2	4	6	7	5
-2		2				2			2	1	1
Total	12	12	12	12	24	24	16	16	16	24	24

School B

Scale Score	Boys		Girls		Below Grade	Above Grade	Arith-metic	Read-ing	Work Skills	White Collar	Skilled
	Gr. 4	Gr. 5	Gr. 4	Gr. 5							
+5				1		1	1				1
+4			3	1	1	3	2	1	1		4
+3	1	6	3	2	6	6	4	2	6	4	8
+2	4	3	4	4	9	6	5	7	3	9	6
+1	4	3	2	4	5	8	3	5	5	9	4
State Average	2				2		1	1		2	
-1											
-2											
-3	1				1				1		1
Total	12	12	12	12	24	24	16	16	16	24	24

*The unskilled classification was here omitted, because of limited sample size in that category.

**The "1" in this column indicates that one group of boys (in this case, high socio-economic livel, Arithmetic, Above Grade) in Grade 4, School A, achieved at a level 4 scale scores above State average. Relative achievement in all classifications in relation to State average is readily seen by observation of results in Schools A, B, C, and D; each school's relative efficiency in all groups is concomitantly observable.

TABLE 4 (continued)

Analysis of Windows With Respect to State Averages: Achievement Classified by Sex, In-grade Position, Subject Area and Socioeconomic Level* - Iowa Tests of Basic Skills

School C

Scale Score	Boys		Girls		Below Grade	Above Grade	Arith-metic	Read-ing	Work Skills	White Collar	Skilled
	Gr. 4	Gr. 5	Gr. 4	Gr. 5							
+5											
+4											
+3											
+2											
+1											
State Average				2	2		1	1		1	1
-1	2	4	3	4	5	8	6	7		8	5
-2	6	5	4	4	11	8	4	7	8	11	8
-3	1	2	4	1	5	3	4	1	3	2	6
-4	3	1			1	3	1		3	2	2
-5											
-6			1	1		2			2		2
	12	12	12	12	24	24	16	16	16	24	24

School D

Scale Score	Boys		Girls		Below Grade	Above Grade	Arith-metic	Read-ing	Work Skills	White Collar	Skilled
	Gr. 4	Gr. 5	Gr. 4	Gr. 5							
+7			1			1			1	1	
+6	1	1	3	1		6	1	1	4	1	5
+5	1		2	1		4	1	2	1	2	2
+4	2			3	1	4	3	1	1	3	2
+3	1	1	2	1	2	3		4	1	1	4
+2	1			2	2	1	1	1	1	1	2
+1	3	3	3	1	8	2	3	3	4	7	3
State Average	3	3	1	3	8	2	4	4	2	5	5
-1		3			3	1	3		1	3	1
Total	12	12	12	12	24	24	16	16	16	24	24

*The unskilled classification was here omitted, because of limited sample size in that category.